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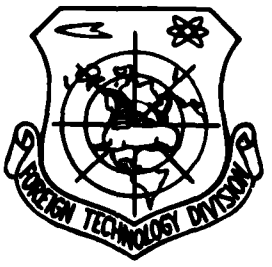
TsAGI
THE CENTER OF AVIATION SCIENCE AND MECHANICS

By

G. Svishchev



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TsAGI
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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yë or ë.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	sinh^{-1}
cos	cos	ch	cosh	arc ch	cosh^{-1}
tg	tan	th	tanh	arc th	tanh^{-1}
ctg	cot	cth	coth	arc cth	coth^{-1}
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

TsAGI

The Center of Aviation Science and Mechanics

G. Svishchev
Corresponding member of the Academy of Sciences of the USSR, Head of the Central Aerohydrodynamic Institute.

A half a century ago the Communist Party and the Soviet Government, supporting the proposal of the outstanding scientist, N. Ye. Zhukovskiy, made the decision to create the Central Aerohydrodynamic Institute - TsAGI. On the first of December 1918 an institute of a completely new type, none of which existed in prerevolutionary Russia, began its operation. The founder of modern aviation science, Nikolay Yegorovich Zhukovskiy, who V. I. Lenin called the "father of modern aviation", was the director of TsAGI. The brilliant theoretician, Sergey Alekseyevich Chaplygin, became his assistant. The decision concerning the creation of TsAGI, made against a background of an intense struggle with foreign intervention and internal counterrevolution, was graphic proof of the foresight of the Communist Party and its understanding of the tremendous role, which science must play in transforming backward Russia into a powerful socialist state.

The Soviet Government charged TsAGI with the formation of the scientific bases of aviation and other new technology, in which definite importance belongs to such disciplines, as aerodynamics, hydrodynamics and strength of materials. Along with this, at the Institute for a period of almost eighteen years (from 1918 to 1936) there were accomplished under the leadership of the outstanding scientist-engineer of our time, A. N. Tupolev, the design and cinstruction of aircraft, many of which, thanks to their remarkable qualities, brought glory to our country. By combining the experimental and theoretical methods of research for the purpose of solving the most urgent problems brought forward by practice, the Institute created a reliable foundation, which ensured the successful development of Soviet aviation and other new technology.

The Beginning of a Long Journey

The initially small - a total of 38 persons - scientific staff of TsAGI, headed by N. Ye. Zhukovskiy, ardently undertook its work. The most intimate scientific colleagues of N. Ye. Zhukovskiy - A. A. Arkhangel'skiy, V. P. Vetchinkin, G. M. Musinyants, G. Kh. Sabinin, B. S. Stechkin, A. N. Tupolev, K. A. Ushakov and B. Yu. Yur'yev assumed the management of the scientific and experimental subdivisions of the Institute. At first , TsAGI, on an experimental basis, used the aerodynamics laboratory of the Moscow Higher Technical College (today the MVTU (Moscow Higher Technical College im. Bayman). Their own scientific laboratories were created simultaneously, the necessary equipment was designed and manufactured, frequently by their own hands. The staff was expanded with enthusiasts of aviation science - college students, and also pilots, those who had participated in the battles for Soviet rule, and former students of the theoretical courses on aviation at the MVTU, which N. Ye. Zhukovskiy had created even before the revolution. Among these were heroes of the Civil War, the pilots,

N. I. Petrov, N. M. Bragin, I. I. Pogosskiy, Ye. I. Pogosskiy, S. G. Kozlov, Ye. I. Stoman and others, who had subsequently become famous scientists, designers, experimenters, who had made their contribution to the development of Soviet science and technology.

Nikolay Yegorovich Zhukovskiy
Portrait painted during an actual sitting in 1919 by the artist S. V. Malyutin. (It is published here for the first time).

TsAGI, even in this period and in all the subsequent years, gave a great deal of attention to the research and works, connected with the requirements for strengthening the defense of the Soviet State. In the Scientific-and-Technical Committee of the Main Adminstration of the Air Force (GUVVF) the TsAGI scientists, together with military pilots and engineers, solved important problems concerned

with design improvements, completion and flight testing of the "Il'ya Muromets" aircraft, which were being adopted by the Air Force, drew a conclusion about the "Porokhovshchikov IV bis" training aircraftand tested the "Spanish-Swiss" ("Ispano-Syuiz") engine, adapted for operation on various fuels. TsAGI sent N. Ye. Zhukovskiy, A. N. Tupolev, B. N. Yur'yev, A. N. Zhuravchenko and V. P. Vetchinkin to a commission at GUVVF (The Main ADministration of the Air Force) on the recreation of heavyaviation. In addressing a meeting of the commission on 8 April 1918, H. Ye. Zhukovskiy focussed special attention on heavy aviation. Having called it the creation of Russia, he emphasized, that its development was necesary to the country bosh for military purposes, as well as for broad civil utilization.

Upon the instructions of the Extraordinary Commissioner for the Supplying of the Army 10 aerosleighs were built at TsAGI for the needs of the Red Army and in 1920 10 more aerosleighs of improved design were built.

The Main Direction

N. Ye. Zhukovskiy and S. A. Chaplygin in their investigations of wing aerodynamics, propellers, air flow and other problems laid the theoretical foundation of aviation science. A new stage in the development of the theory and the creation of aviation engineering science - a reliable basis for the practice of Soviet aircraft construction-- was connected with the organization of TsAGI, in proportion to its formation and development of an experimental and productive base and its attraction of more and more young talented scientists. For the period of its entire 50 years great attention at TsAGI to an equal degree has been given to theoretical problems, to the development of experimental methods of research, to the creation of engineering methods of design and the testing

of individual elements and an aircraft as a whole.

In December 1925 TsAGI began operation of the largest wind tunnel in the world, at that time, the T-I - T-II wind tunnel, built in accordance with the design of the following workers of the institute: K. K. Baulin, G. M. Musinyants, K. A. Ushakov, A. M. Cheremukhin and B. N. Yur'yev. Its introduction into operation made it possible for the scientists to proceed with the in-depth study of a large number of important problems of aircraft aerodynamics. As a result of the experimental and theoretical research, carried out at the Institute, Soviet scientists were able at the beginning of the 20's to begin the transition from wooden truss and biplane designs of aircraft to metal monoplane designs.

In 1923, the first light Soviet aircraft, the ANT-1, was built in accordance with A. N. Tupolev's design; it had certain components made from Kol'chug-aluminum (a Duralumin-type alloy) - a metal, created by Soviet scientists and workers and produced by the Kol'chug plant. In 1925, a combat aircraft of completely metal construction - the ANT-3 (R-3) - had already been airborne.

In recognizing the services of TsAGI in the solving of important problems of Soviet aircraft construction and the development of aviation science, the Presidium of the TsIK (Central Executive Committee) of the USSR awarded the Institute the Order of the Red Banner of Labor for its work in the area of aerodynamics, which produced important results in the development of the Soviet aviation industry, for the solution of the problem of metal aircraft construction and the organization of the first series production of metal combat aircraft on 26 April 1926.

The years of the successful accomplishment of the industrialization of the country under the leadership of the Communist Party were saturated with especially significant events in the development of aviation science and technology. New aircraft, engine and accessories plants were constructed and many old aviation enterprises were substantially reconstructed and re-equipped. In 1930-31 new special scientific-research institutes were created on the basis of TsAGI departments and laboratories: the All-Union Institute of Aviation Materials (VIAM), the Central Institute of Aviation Engine Construction (TsIAM),the All-Union Institute of Hydraulic Machine Construction (VIGM) and the Central Scientific Research Institute of Wind Power (TsEI), whoae activities had a shaping effect on the development of the corresponding divisions of science and technology.

The constant expansion of the network of scientific institutions, and in particular, those occupied with aviation problems, became possible as a result of the fact, that the broad masses of workers received the possibility to acquire knowledge. The Communist Party and the Soviet Government, concerned about the creation of a new technical intelligensia, opened the path to science to the working people, and like Lenin cautiously trained young scientists and directed their creative activity. The Party line on combining olf and young scientific cadres and their amicable work for the good of the Fatherland gave excellent results.

The significant stage in the development of theoretical aerodynamics and hydrodynamics is connected with the names of our outstanding scientists: M. V. Keldysh, N. Ye. Kochin, M. A. Lavrent'yev, A. I. Nekracov, G. I. Petrov, L. I. Sedov, L. N. Sretenskiy, who worked in the theoretical group of TsAGI, then headed by S. A. Chaplygin. Fundamental results in the investigation of numerous problems,

on the solution of which depended increasing the aeronautical engineering qualities of aircraft, and also in the solving of many important problems of hydrodynamics, were obtained by them and other scientists of TsAGI.

In the wind tunnels of TsAGI V. P. Gorskiy, F. G. Glass, A. K. Martynov, V. G. Hikolayenko and other workers of the Institute carried out systematic investigations of the aerodynamics of wings, fuselages, empennages, landing-gear fairings, cowlings of engines and radiators. Scientists V. S. Pyshnov (the Air Force Engineering Academy im. N. Ye. Zhukovskiy) and A. N. Zhuravchenko carried out the first comprehensive investigations of such a dangerous phenomenon, as aircraft spin.

Considerable successes were achieved in the development of methods of designing and strength testing of aircraft. A. A. Goryainov, S. N. Shishkin, A. I. Makarevskiy, T. A. Frantsuz and other scientific workers, in essence, created the first domestic strength standards, which played a very important role in ensuring aircraft flight safety. Stress analysis methods for aviation structures were developed and the causes of the onset of vibrations in aircraft were investigated. V. N. Belyayev, A. Yu. Romashevskiy, G. S. Yelenevskiy, I. V. Anan'yev and many other workers at TsAGI actively participated in these important investigations.

In the years of the pre-war five-year plans, at the height of the carrying out of the Lenin plan for the industrialization of the country, investigations of a number of urgent problems of industrial aerodynamics were carried out on an especially broad scale at the Institute. Entire series of fans, wind engines, compressors and other machines and devices were developed and studied in detail. A large number of enterprises, coal mines and the Moscow subway received TsAGI

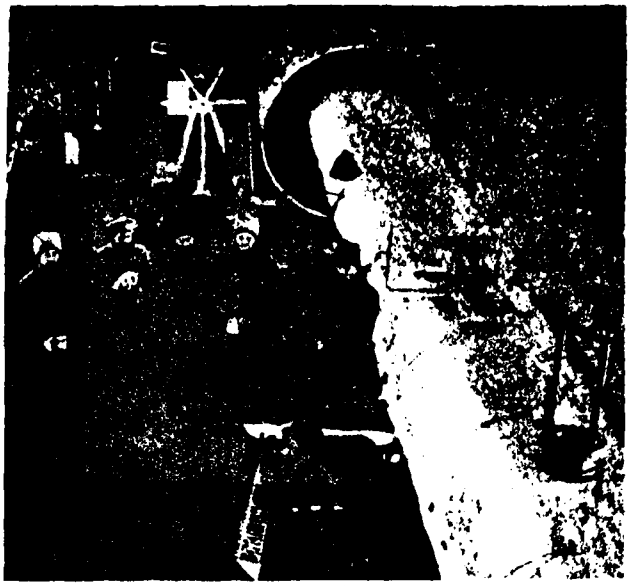
fans, possessing high effectiveness; these fans had been investigated by K. A. Ushakov, G. Kh. Sabinin, A. G. Bychkov, V. I. Polikovskiy, G. N. Abramovich, S. A. Dovzhik, E. L. Blokh, M. Ya. Gembarzhevskiy and other workers.

The Party and the government evaluated the selfless labor of the Institute staff highly. On December 1933, in connection with the fiftennth anniversary , TsAGI was awarded the Order of the Red Banner.

The theoretical investigations, experiments and the practical recommendations worked out by TsAGI on their basis made it possible for the Soviet design staffs to create perfected combat and transport aircraft and reliable engines. In the numerous nonstop flights and aviation records, established in the period of the postwar five-year plans, Soviet pilots graphically demonstrated the excellent qualities of their aircraft and engines, the originality and inventiveness of the Soviet design and technological school, the creative independence of Soviet scientific thought and the great achievements of Leninist politics in industrializing the country.

The creation of a powerful Soviet aviation industry was the durable and reliable basis for the subsequent development of Soviet aviation. The Party confronted the scientists and designers with the problem of achieveing new heights in the development of Soviet aviation science and technology. The necessity for in-depth and multisided investigations required the creation of a new experimental basis for TsAGI, including full-scale high-speed wind tunnels and devices for investigatin design strength. In 1936 the construction of a new scientific base for TsAGI was begun. As early as a year later small wind tunnels had already begun operation, and in the fall of 1939 flow was obtained in the T-101 and T-104

full-scale wind tunnels.



N. Ye. Zhukovskiy and his students at the wind tunnel in Kuchino. Winter of 1919.

A new TsAGI was created not far from Moscow. Our aviation had obtained a unique scientific base.

Everything for Victory

In the years of the Great Fatherland War - this most severe experience, which our people bore so heroically and steadfastly, the main efforts of the scientific staff of TsAGI were directed at rendering aid to the front and towards creating the bases for further progress in aviation technology. "Everything for the front, everything for victory" - this slogan of the Communist Party determined the activity and the direction of the efforts of each scientist, worker, experimenter and all the employees of TsAGI.

The scientists of TsAGI - I. V. Ostoslavskiy, V. G. Nikolayenko, Ye. I. Kozlov, K. A. Ushakov, S. L. Zak, V. N. Matveyev and their young assistants carried out a series of important investigations in the T-101 and T-104 wind tunnels. On the basis of these TsAGI recommended a number of measures, which helped to raise the combat qualities of many aircraft, which were in series construction.

Many problems of aerodynamics, flight dynamics, strength of materials and the aeroelasticity of aircraft and propellers and other things, important for the practice of aircraft construction were resolved at TsAGI. In ensuring flight safety an important contribution was made at a very early stage byt the first investigation of such an important phenomenon, as aircraft spin. A subsequent significant advance was achieved here in the rational principles of aircraft layout, developed at TsAGI. The introduction into operation of the vertical or, as it is sometimes called, "Spin" wind tunnel helped. From the results of the testing of dynamically similar models to spin the sequence of the effects of the control elements, which ensure reliable emergence from spin, was determined (Ye. A. Pokrovskiy, A. I. Nikityuk, M M. Mikhaylov et al.).

The scientists P. P. Krasil'shchikov, A. B. Risberg and other workers of TsAGI developed a concept of such a wing layout, in which a separation flow character, caused by an increase in the angle of attack, arises first in the root section of the wing and slowly develop along the span, in proportion to the increase in the angle of attack. The designing of wings, taking this concept into consideration, promoted the preservation of transverse and longitudinal controllability at large angles of attack. A significant contribution in the development of aerodynamics was made by G. N. Abramovich, L. G. Loytsyanskiy, K. K. Fedyayevskiy, M. D. Millionshchikov, who investigated free jets, boundary layer and turbulence pro-

blems.

The scientific workers A. K. Martynov, V. S. Vedrov, G. S. Kalichev, V. N. Matveyev, G. S. Byushgens, A. L. Raykh, A. V. Nikolayev, M. A. Tayts, test pilot A. N. and others studied the questions of controllability, the aerodynamics of empennages and downwash in the region of the empennage. The designers and pilots found in these works the necessary criteria for evaluating the stability, controllability and maneuverability of aircraft.

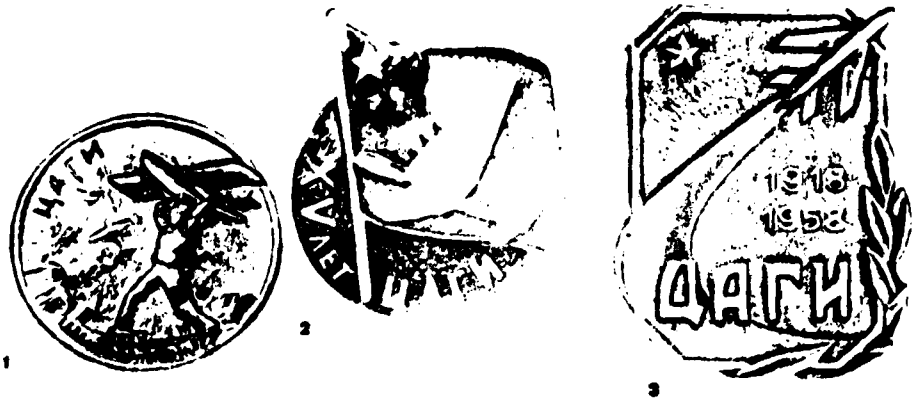
The improvement in the aerodynamics of aircraft and propellers and the increase in engine power ensured an increase in the maximum speed of aircraft. However, with an unfavorable relationship between design rigidity and the aerodynamic characteristics of aircraft elements dynamic loss of stability can arise. It is characterized by a very rapid increase in the undamped oscillations of the structure, which usually conclude with the breakup of the aircraft in the air. This dangerous phenomenon has received the name flutter.

The TsAGI scientists M. V. Keldysh, Ye. P. Grossman, and subsequently Ya. M. Parkhomovskiy, L. S. Popov, S. P. Strelkov and other developed reliable methods for determining critical speed. These methods are now broadly employed in Soviet aircraft construction practice.

Certainly, it is not possible, in one article, to list even the most important scientific works, carried out in the departments and laboratories of TsAGI during these years. On the basis of the results of many years of research by the scientists of the Institute and the generalization of the experience of the design office "A Manual for Designers" , issued in 1943, was created. The design methods, employed in aircraft design and many specifications, the execu-

tion of which was necessary for obtaining a rational aerodynamic layout of an aircraft, are presented in it.

The Communist Party and the Soviet Government highly valued the activity of the staff during this period. In September 1945 the Supreme Soviet of the USSR awarded TsAGI the Order of Lenin for outstanding service in the area of scientific-research works on aviation and in connection with its 25-anniversary.



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Memorial and Anniversary Badges

During the fifty year existence of the Central Aerohydrodynamics Institute memorial and anniversary badges were issued more than once. The first of these appeared for the tenth anniversary of TsAGI in 1928. V. Kondorskiy, one of the oldest workers of the Institute was its creator.

...A worker raising an airplane above his head is depicted in the foreground. Below there is the silhouette of the building of a wind tunnel, to the left are the capital letters - TsAGI (Photo no. 1).

A new badge was issued in 1933 marking the 15-th anniversary of TsAGI. It is a circle with a streaming flag above. Under the flag is a superimposed silhouette of the propaganda aircraft, "Maksim Gor'kiy", along the circumference on a blue background are the Roman numerals XV and the letters - TsAGI (Photo no. 2).

The anniversary badge for the 40-anniversary of TsAGI, made at the Moscow mint, was made in the shape of a rectangle with the corners cut along the diagonal, and on it is a jet aircraft shooting upwards. Under the aircraft are two dates: 1918, 1958 (Photo No. 3).

The memorial badges were awarded to veterans of laboe - workers, technicians, engineers, aviation designers, scientists, who have worked many years at TsAGI. They received these badges for the fiftieth anniversary of the Institute.

Collector, B. Medyntsev

At a New Stage

The next important stage in the scientific activity of TsAGI is connected with the radical technical re-equipping of our aviation - with the creation of transonic aircraft with jet engines. A number of fundamental investigations make up the theoretical bases of the aerodynamics of high speeds. The investigations of S. A. Chaplygin, M. V. Keldysh, F. I. Frankl', S. A. Khristianovich, A. A. Dorodnitsyn, G. I. Petrov, L. I. Sedov, M. D. Millionshchikov and others are concerned with these works.

The scientists of TsIAM (Central Scientific Research Institute of Aircraft Engines im. P. I. Baranov) and the design staffs, directed by A. A. Mikulin, B. S. Stechkin, V. Ya. Klimov, successfully developed the first jet engines. There were opened up to aviation the prospects for an increase in the maximum flight speed of aircraft, unkown up to this time. It was necessary to study the laws of the flow of an incompressible gas around a body, to discover the rational shapes of aircraft elements and the layouts of aircraft, which ensure low drag, acceptable characteristics of stability, controllability and strength.

As early as the years of the Great Fatherland War the construction of a high-speed and variable density wind tunnel was begun and completed. The starting of its operation in 1943 made it possible for the workers of TsAGI to begin an in-depth study of the effect of air compressibility and Reynolds number* on the character of the flow around aircraft elements and the aerodynamic characteristics of aircraft. It was clear, that the mastery of very high-speed flight was connected in a definite manner with the possibility of penetrating into the mechanism of flow around bodies at near-sonic, transonic and supersonic speeds. These years were undoubtedly extremely important for the development of aviation science. Let us dwell on only a few of the results of the findings.

The investigations of the TsAGI scientists established important flow properties - the stabilization of local M numbers near wing profiles at Mach numbers greater than critical Mach numbers (S. A. Khristianovich, I. P. Gorskiy, V. G. Gal'perin, A. P. Kovalov). As a result of many years of work A. K. Volkov, P. P. Krasil'shchikov, M. V. Ryzhkova, Ya. M. Serebriyskiy, R. I. Shteynberg and others developed a series of profiles for wings and empennages with high aerodynamic perfection. These profiles have been used on many Soviet aircraft.

Of great theoretical and practical significance were the investigations of V. V. Struminskiy, N. K. Lebed', K. K. Kostyuk, G. S. Byushgens, V. S. Polyadskiy, A. B. Lotov, A. Zh. Rekstin, G. A. Yudin, P. P. Krasil'shchikov, K. P. Petrov, and L. N. Yakovleva, which were dedicated to the study of the peculiarities of swept and low-aspect-ratio wings. They solved many problems concerning the stability of aircraft with these types of wings and with new types of empennages. V. S. Polyadskiy, N. I. Sharokhin and other scientists demonstrated with their works, that by giving special shapes to the fuselage and the engine nacelles and by positioning them rationally relative to the wing designers can significantly decrease the effect of harmful interference** at high Mach numbers and in the transonic region.

An important event in the development of Soviet aviation science was the obtaining in wind tunnels and at other installations of near-sonic speed of flow with continuous transition through the speed of sound. The scientists S. A. Khristianovich, S. A. Aristrakhov, B. V. Belyanin, I. P. Gorskiy, V. G. Gal'perin and other were the first ever to create in practice a reliable "instrument", which made it possible to investigate aerodynamics and the problems of aeroelasticity in this most difficult region of speeds, which our aviation had to tackle.

A model of the supersonic passenger aircraft Tu-144.

After only a lapse of one year, in December 1948 the La-176 aircraft attained a flight speed, equal to the speed of sound, and in December the MIg-17 aircraft exceeded the sound barrier. The employment of a new - swept-like wing shape, a rational arrangement of all the structural elements and the VK-1 jet engine endowed this multipurpose aircraft with high speed, reliability, stability and good controllability.

The creative cooperation of the designers, production workers and the scientists brough a very important victory to the Fatherland.

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The beginning of the 50's was marked by investigations, directed towards the achievement of even higher speeds and by the creation of effective power plants for such aircraft. The solution of these problems was promoted by the investigations of G. I. Petrov, Yu. N. Vasil'yev, A. V. Nikolayev, I. S. Simonov and many other scientists, which were dedicated to the aerodynamics of supersonic diffusers.

Significant progress was attained as a result of the employment in jet

engines of supersonic compressors, proposed and studied by the workers of TsAGI and the Central Scientific Research Institute of Aircraft Engines im. P. I. Baranov (TsIAM) Yu. I. Vasil'yev, Yu. G. Zhulev, B. S. Dorogov, K. A. Ushakov and S. I. Ginzburg.

Of great importance for the development of supersonic aircraft construction were the investigations of co-axial propellers for turboprop engines, carried out by the the scientists of TsAGI D. V. Khalezov, A. I. Pozhalostin, S. L. Belkin, G. M. Fomin. B. P. Blyakhman, G. I. Maykapar. As a result of the the joint work with the design staffs, headed by N. D. Kuznetsov, K. I. Zhdanov and K. V. Minkner the outstanding propeller-engine group, which had no equals in the world in practice, was created for the Tu-144 aircraft.

During all of these years much attention was given to the investigations of aircraft hydrodynamics, and the hydrodynamics of motor launches, ships and other bodies. Very significant and important results of the investigations of hydroplaning, impact on water, hydrodynamics of hydrofoils, aircushion effect, navigability of ships and phenomena of cavitation for practical application, were obtained in numerous experimental and theoretical investigations, carried out at TsAGI by A. N. Vladimirov, L. A. Epsteyn, V. G. Frolov, A. B. Lotov, M. D. Khaskind, K. K. Fedyayevskiy, G. V. Logainovich and others.

The practical demands of helicopter construction caused at TsAGI a broad expansion of the investigations of the most essential problems of the aerodynamics, flight dynamics and strength of helicopters (B. N. Yur'yev, I. P. Bratukhin, M. L.Mil', A. N. Mikhaylov, L. S. Vil'dgrube, B. Ya. Zherebtsov, V. E. Baskin, V. A. Fedulov, I. O. Faktorovich and many others). The staffs, commanded by M. L.

Mil' and N. I. Kamov, in cooperation with the scientists and the technologists, created a whole series of helicopters with different purposes and possessing high reliability and acceptable economy.

In the postwar years, especially after 1955, the civil air fleet developed rapidly. The aviation industry in our country created outstanding designs of passenger aircraft with turbojet and turboprop engines - the Tu-104, Il-18, An-10 and the Tu-114, and somewhat later - the Il-2, Yak-40 and the Tu-154. In the projects, developed by the design offices, the results of the special investigations of aerodynamics, flight dynamics and the problems of the long-term strength of the design elements of pasenger aircraft, carried out at TsAGI, were employed. Ways were found to increase the effectiveness of new machines by increasing their aerodynamic efficiency, and also ways were proposed for improving take-off and landing properties, for increasing reliability and lengthening service life.

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The contemporary stage in the development of aviation science and technology is characterized by investigations and the development of aircraft, which fly at speeds, exceeding the speed of sound by several times, with variable wing sweep during flight and of VTOL aircraft (SVVP), etc. The theoretical basis, laid by S. A. Chaplygin as early as 1902, has, in the intervening 50 years, been significantly expanded by the scientists at TsAGI and other scientific research institutes. It was possible to discover new phenomena, to obtain a number of accurate solutions, to penetrate into the fine mechanism, which controls flow at Mach numbers greater than 1. The new results in these areas of aviation science were obtained by A. A. Nikol'skiy, G. I. Maykapar, G. L. Grodzevskiy, V. V. Keldysh, V. V. Sychev,

G. I. Taganov, V. M. Shurygin, R. I. Shteynberg, M. N. Kogan, V. N. Zhigulev, Yu. A. Zhilin, L. Ye. Vasil'yev, A. A. Gladkov and other scientists.

Aviation's mastery of supersonic speeds required new theoretical and experimental investigations. For this, high supersonic speed wind tunnels were constructed and a number of special installations and instruments was created. The tempo of the investigations and the design execution of the new aircraft with variable sweep wing, created by our aviation industry caused astonishment throughout the world. New forms and principles of aircraft design firmly entered into aviation practice in an unprecedentedly short period of time.

The successes of Soviet aviation science and technology, achieved under the leadership of the Communist Party, were graphically demonstrated at the anniversary holiday in July 1967 at Domodedovo. Military aviation became supersonic and rocket-carrying. The day is not very far off, when supersonic aircraft will also be employed on the civil aviation line. Many years of investigations of aerodynamics, flight dynamics, strength of aviation designs at high temperatures, the successes in engine construction and technology made it possible for our aviation industry to earnestly approach the solution of this problem.

The past decade has been characterized by the further expansion of the front of scientific quest. The staffs of many scientific organizations are participating in it. Significant results have been obtained in aerodynamics and thermal physics.

TsAGI has developed along with the aviation industry, working in close cooperation with the design office and the factories. The shaping influence

of TsAGI on the development of aviation science and technology has been considerable due to the attention, which the Communist Party and the Soviet Government has given to the development of science in our Fatherland.

* Reynolds number - is the dimensionless characteristic of flow - it represents a ratio: the products of density by flight speed and a characteristic linear dimension, to the coefficient of viscosity of a liquid or gas.

** That is, of the mutual effect of the parts of an aircraft, for example, of wing and fuselage, nacelle and wing.

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